Progress and Findings of the Decomp(artmentalzation) Physical Model

RECOVER Science Meeting

West Palm Beach, FL. March 1, 2016

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Critical DPM Questions

Restoration: What is the ecological function of sheetflow and what are the hydrologic needs (i.e., flow fields, depths, duration) of the ridge and slough landscape?

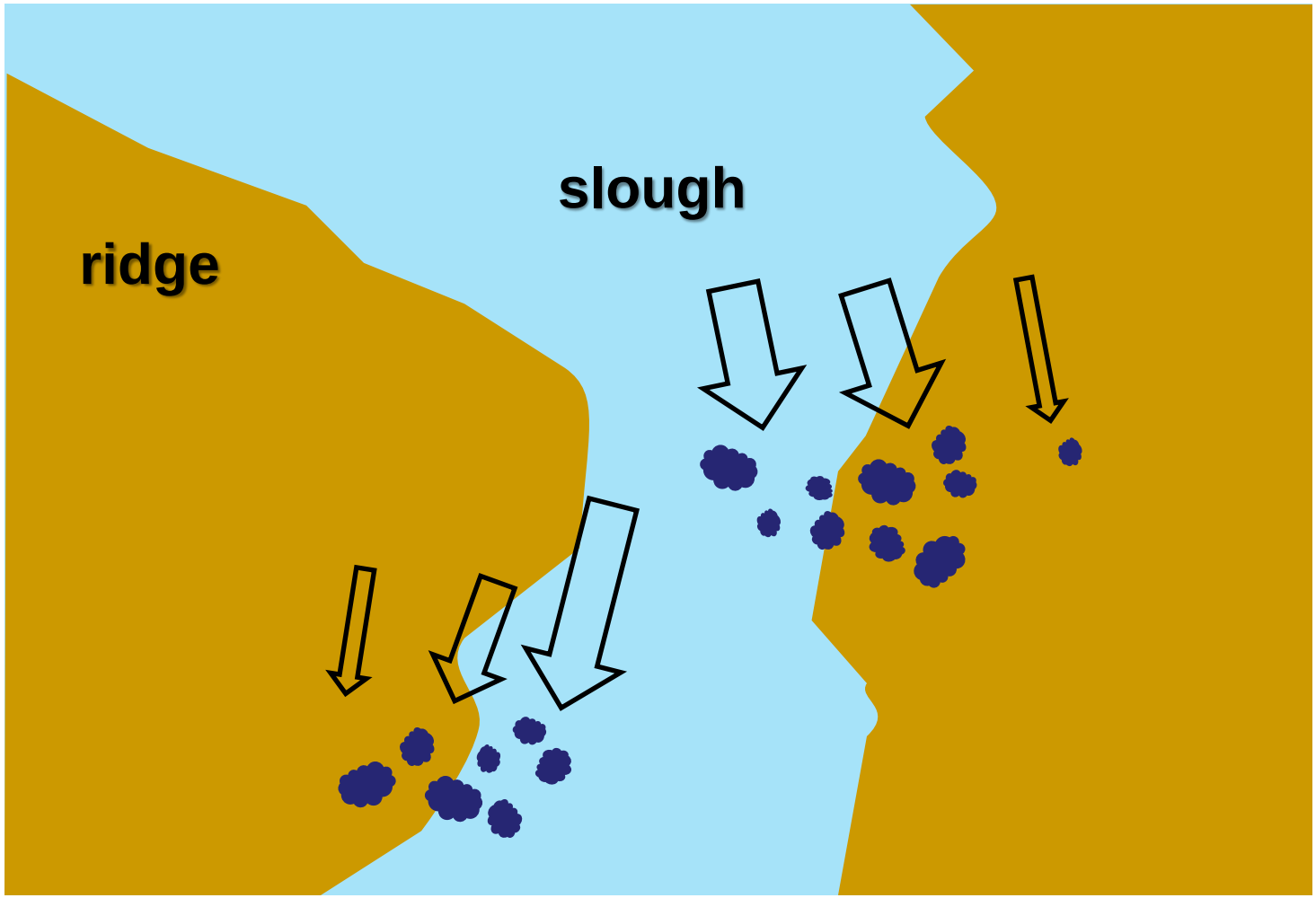
Sediment: What is the role of floc and sediment movement for restoring and sustaining a stable ridge and slough landscape? What are the impacts on biogeochemical cycling?

Backfilling: how do canals, levees, and levee modifications affect sediment movement? Fish populations?

Sheetflow Hypothesis Cluster

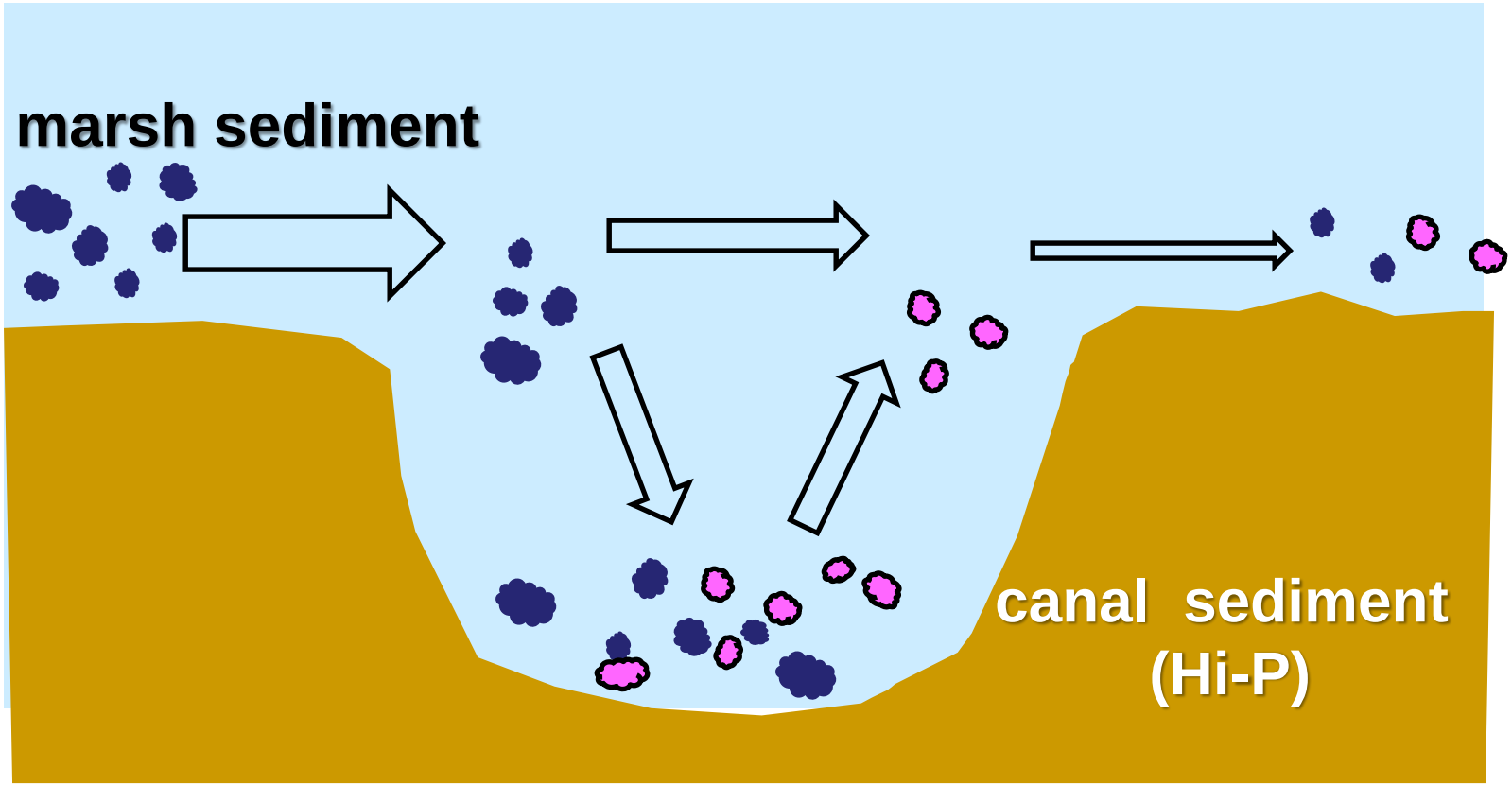
Deep water sloughs exhibit higher velocities, more sediment transport

High-flow redistributes sediment from sloughs into ridges

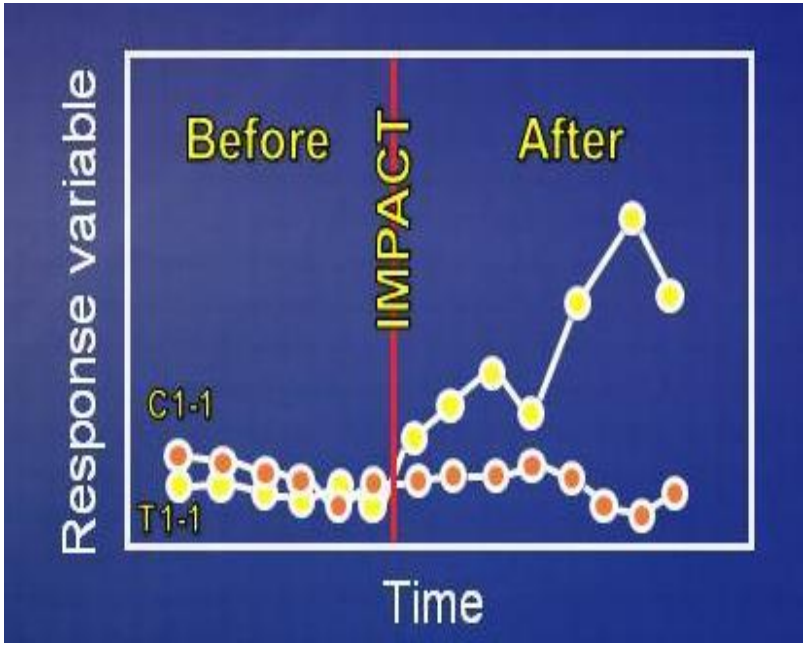


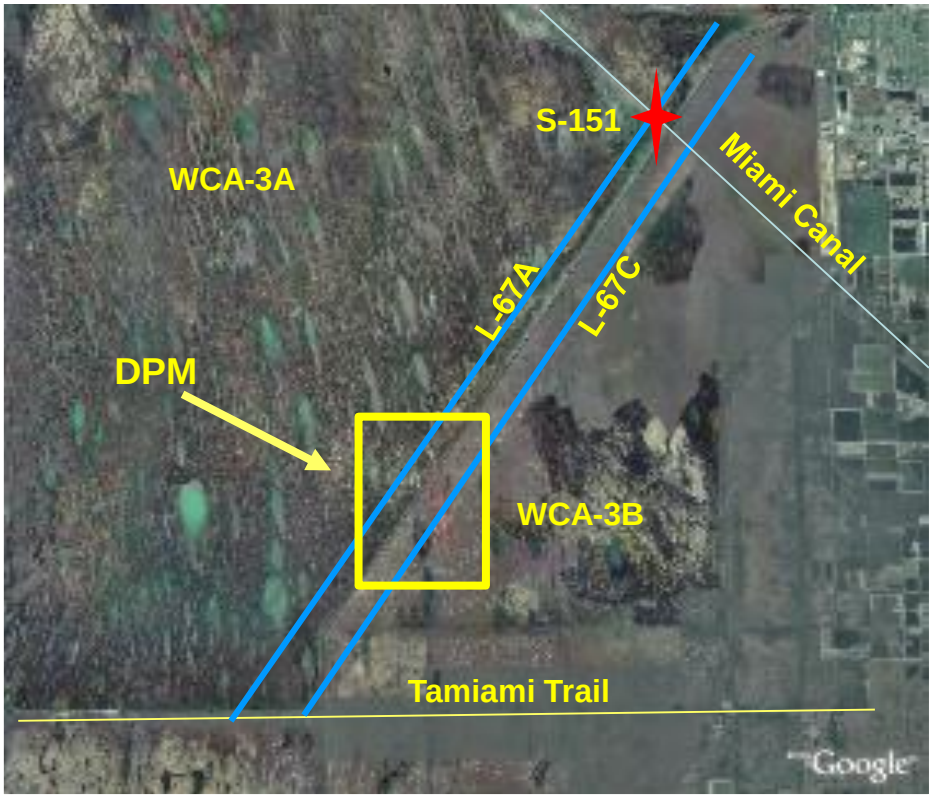
Canal Backfill Hypothesis Cluster

Is canal backfilling needed to maintain sediment transport?
Does backfilling prevent downstream nutrient loading?
Does backfilling impact fish populations?



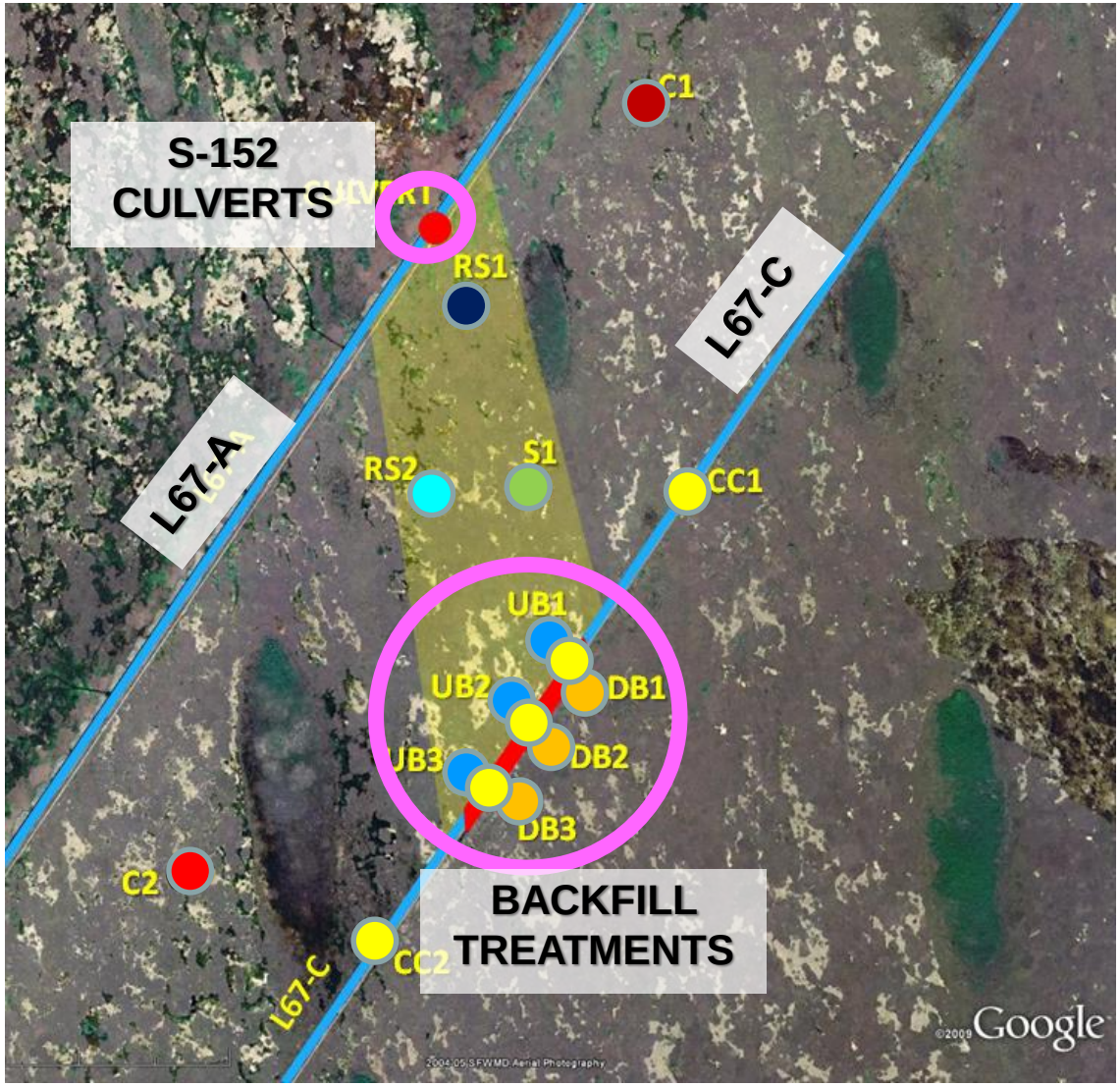
DPM Experimental Design



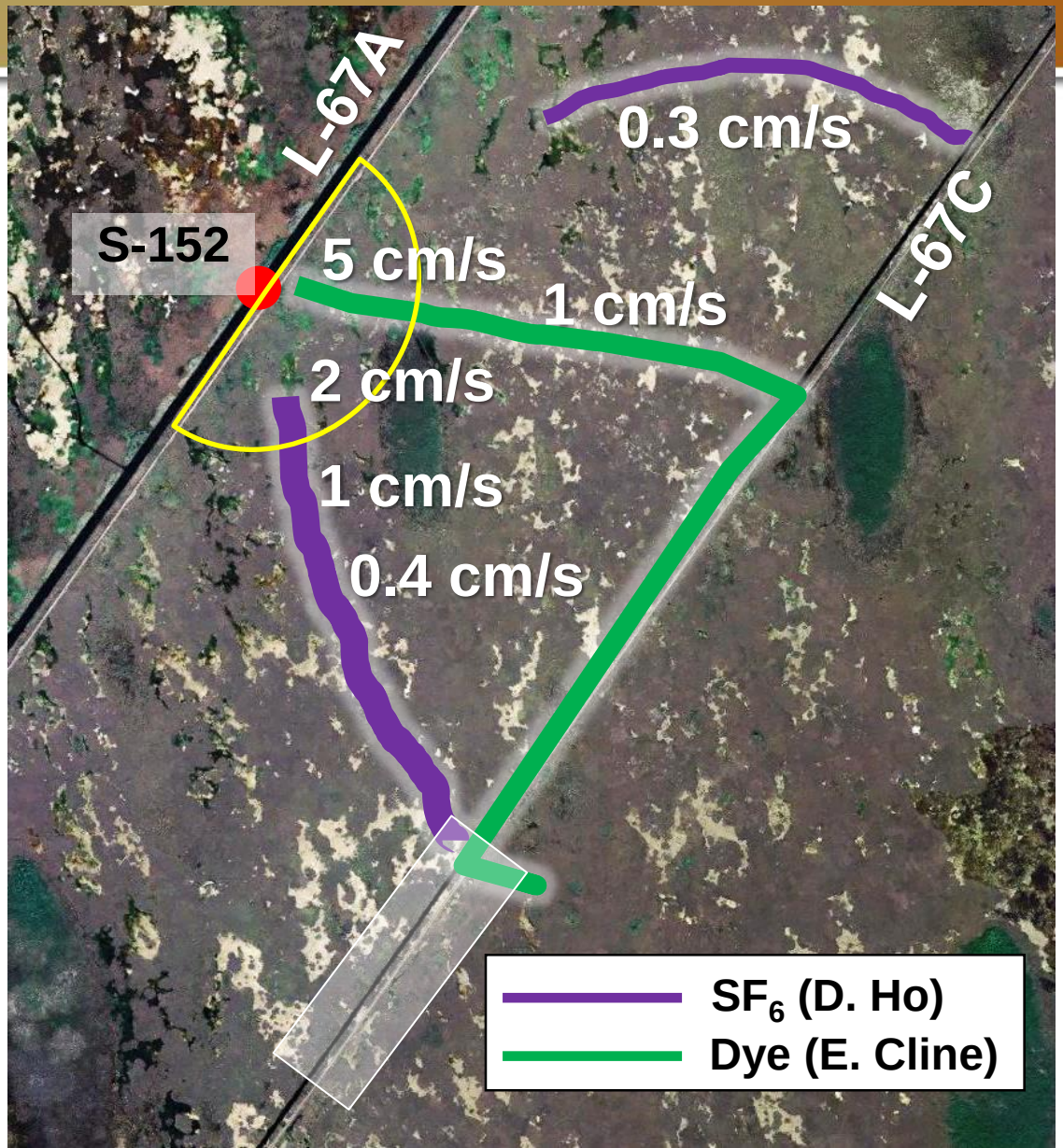


DPM Experimental Design

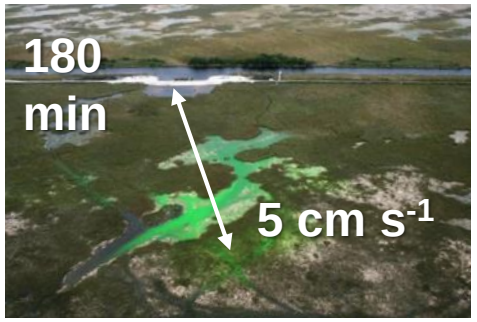
- **Construction**
  - L67A: ten 6-ft gated culverts
  - L67C: 3000-ft gap and 3 canal-backfill treatments
- **BACI design**
  - 11 marsh sites
  - 5 canal sites
  - Before-, Impact- sampling
- **S-152 Operational constraints**
  - Flooding in WCA3B
  - Water quality in L67A
  - Operational window is November-January



Flow field resolved with water tracers

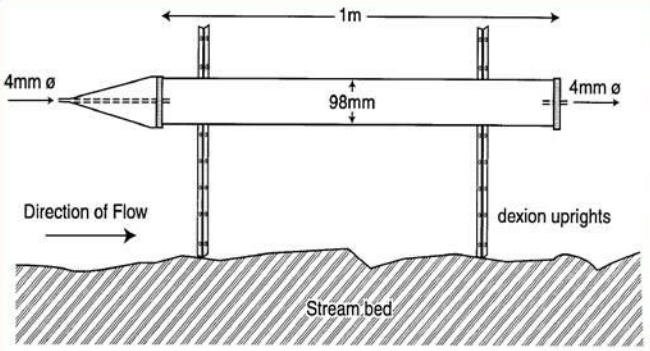


Dye tracer, 2013

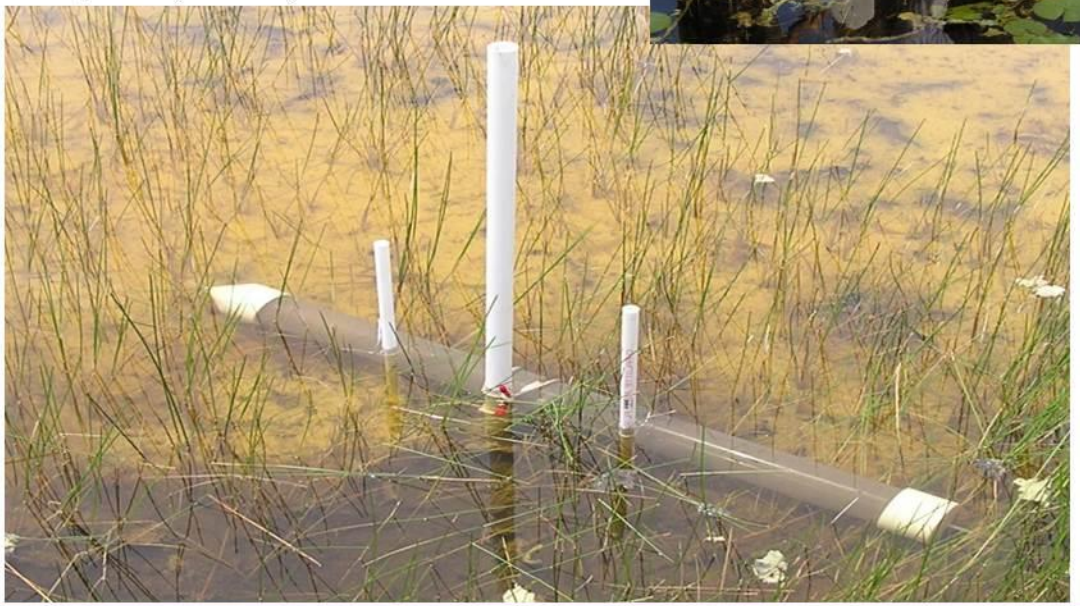


Flow Effects on Sediment Transport – Horizontal Traps

- adapted from Phillips et al., 2000 *Hydrol Procs.*
- Mid-water column, parallel to flow
- Deployed at spatial sites
- Nov-Jan 2012, 2013, 2014, 2015 …



Phillips et al., 2000 *Hydrol. Procs*



Data from C. Saunders, SFWMD

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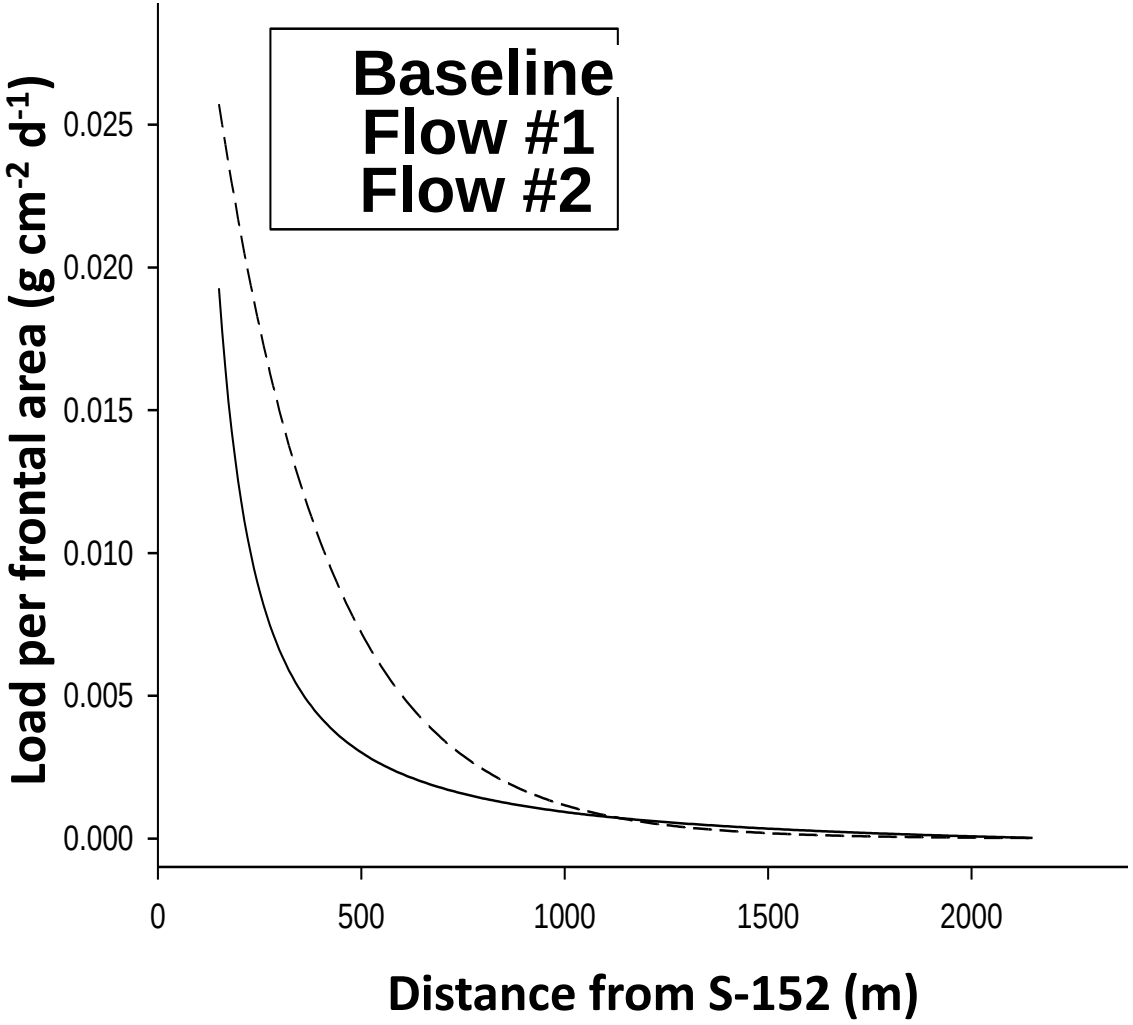
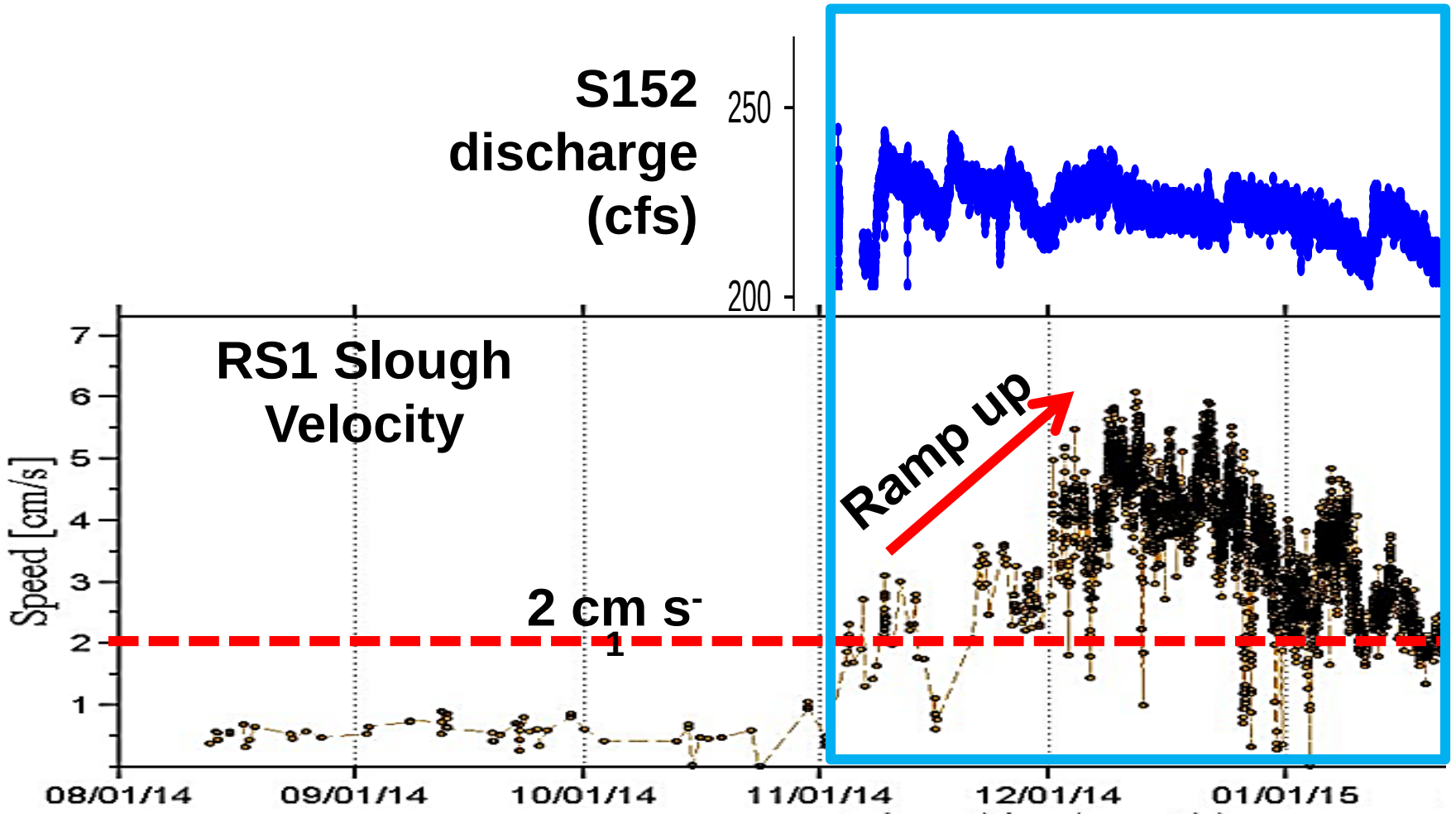


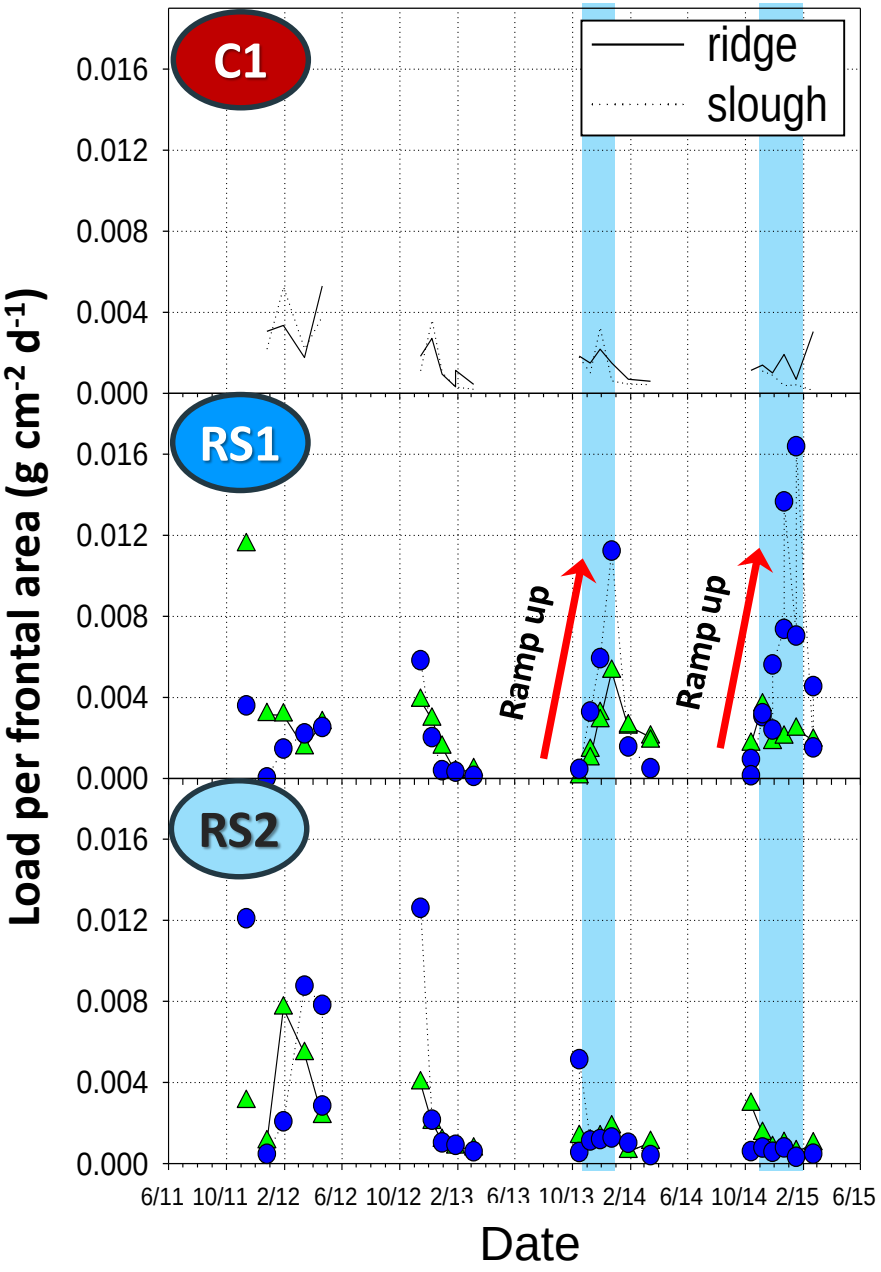
Data from C. Saunders, SFWMD

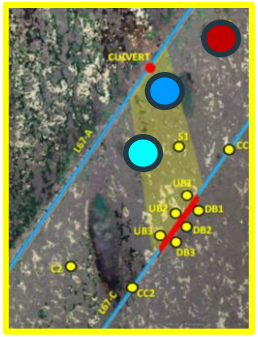
Benefits of Sustained Discharges – Slough Velocities Increase



Data from Jud Harvey, Jay Choi and Mark Dickman, USGS

- **Sediment Transport RAMPS UP with sustained flow**
  - BACI sampling
  - C1, RS1, RS2
  - ridge & slough
  - 3-wk Oct-Jan, 6-wk Feb-April
  - 2011, 2012, 2013, 2014

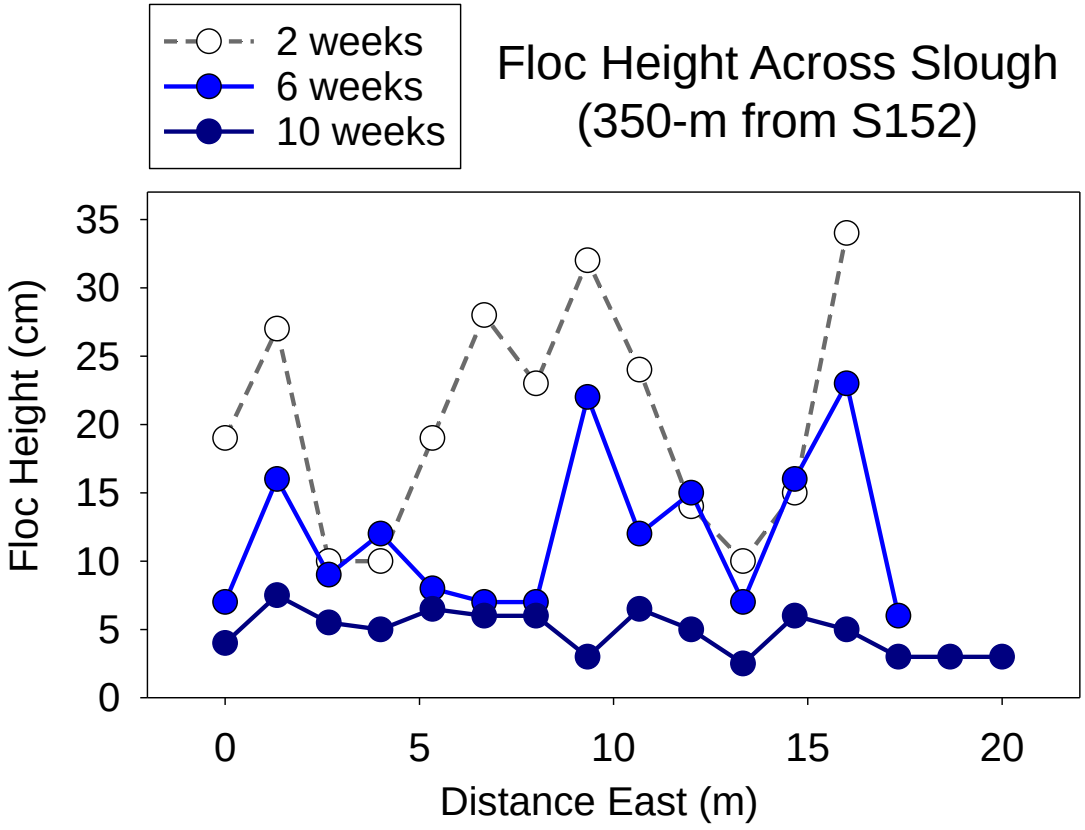




Data from C. Saunders, SFWMD

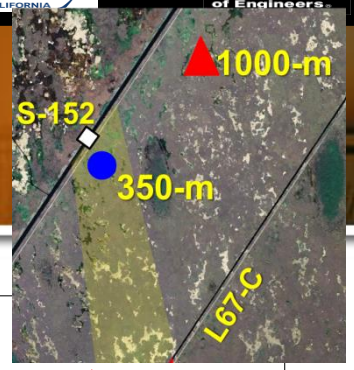

RS1 slough - pre-flow

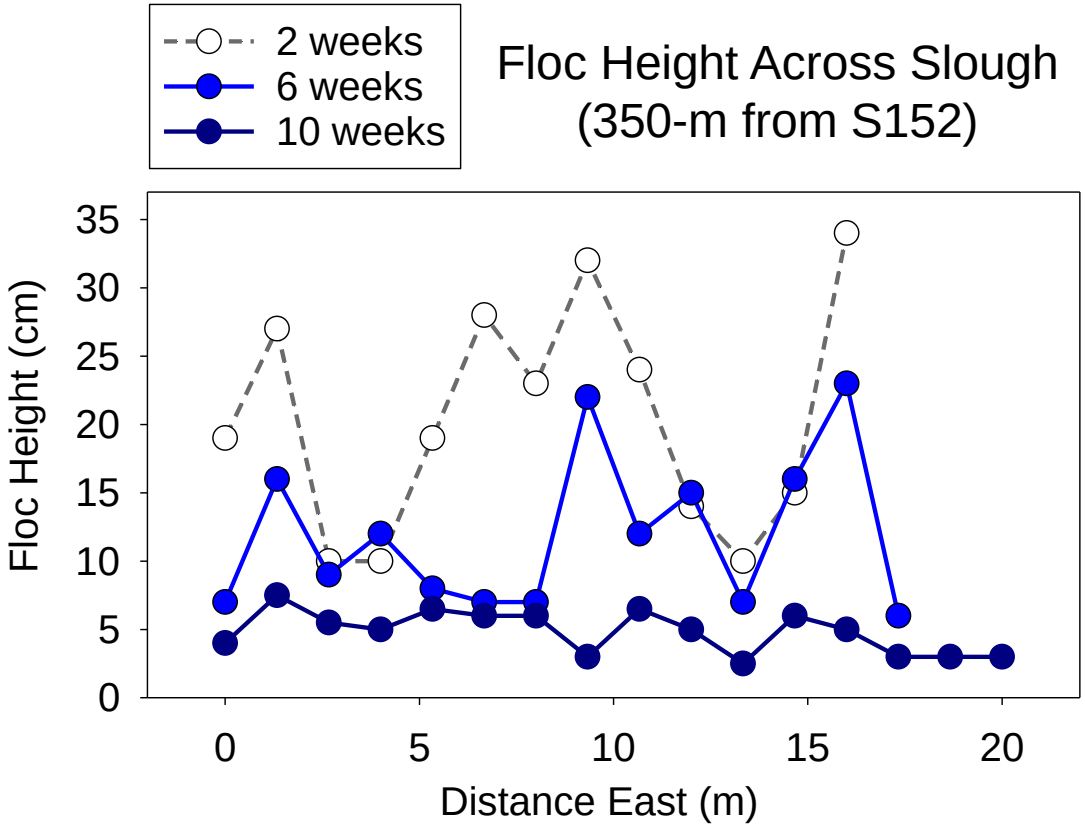
Slough Floc Reduced Under Sustained Flow

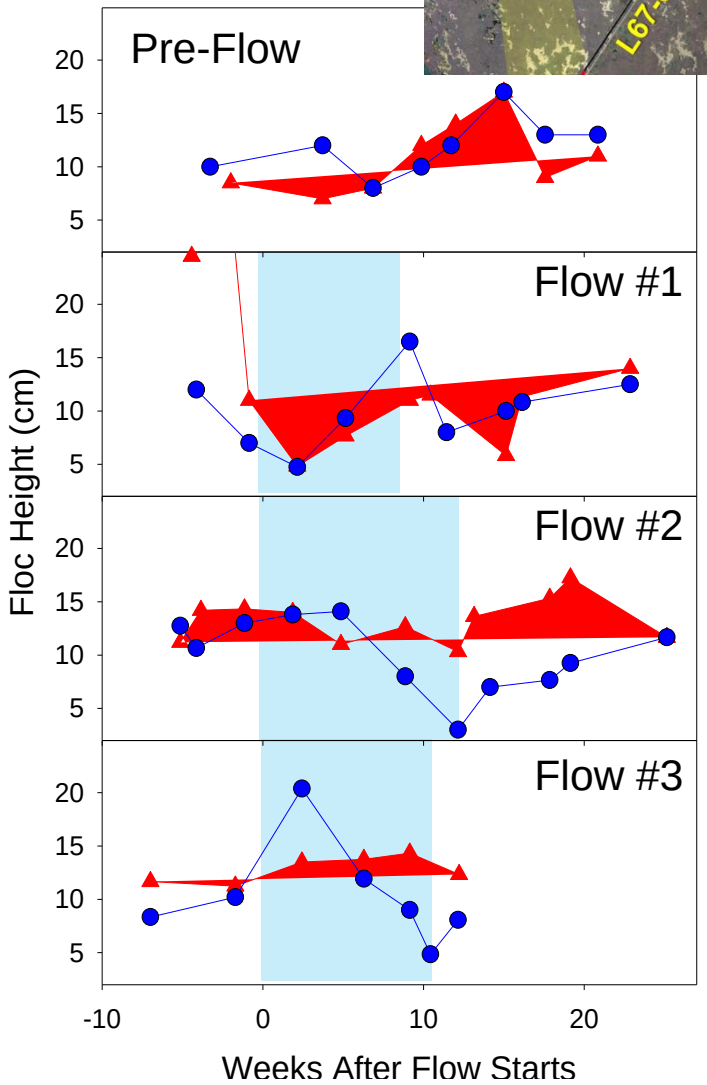


Data from C. Saunders - SFWMD

Slough Floc Reduced Under Sustained Flow







Data from C. Saunders - SFWMD

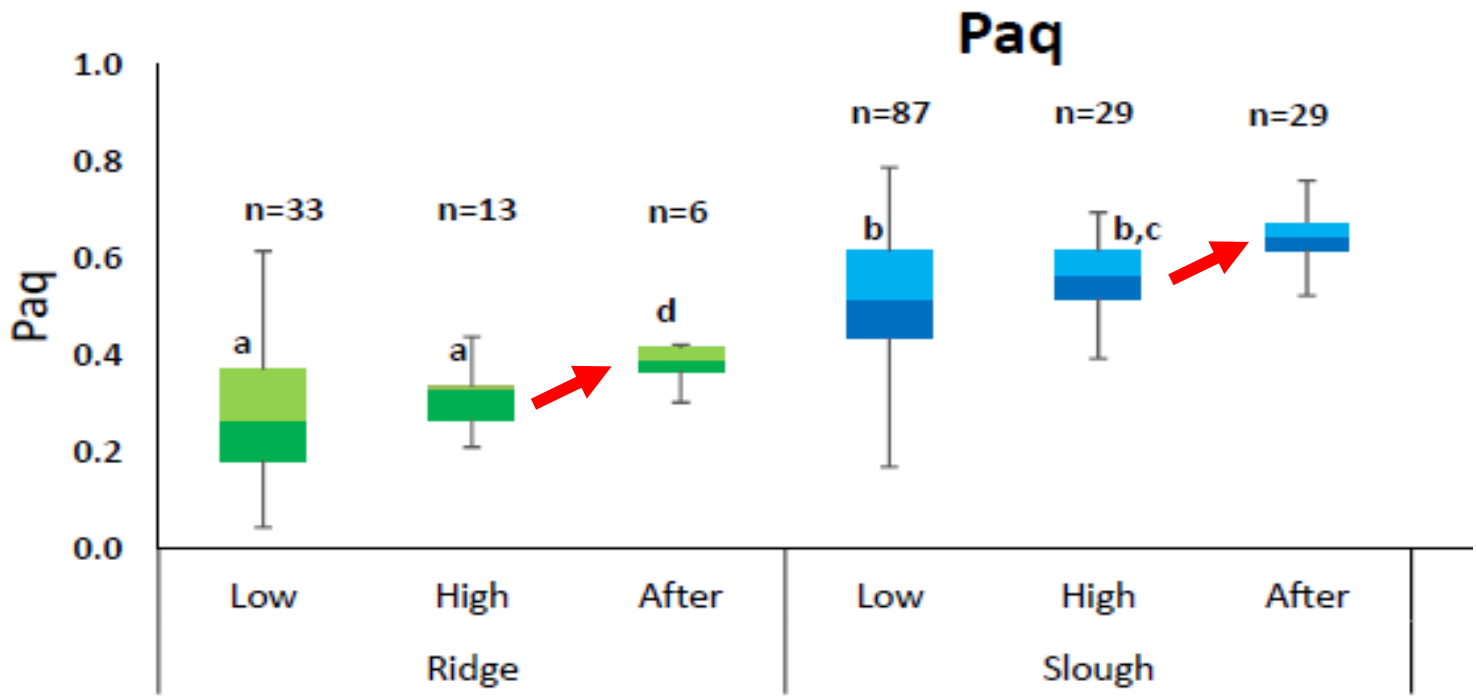
Paq – Biomarker for Slough vs Ridge Organic Matter

$$\mathbf{P}\boldsymbol{aq} = (C_{23}+C_{25})/(C_{23}+C_{25}+C_{29}+C_{31})$$

n-alkane

R. Jaffe, D. He (FIU)

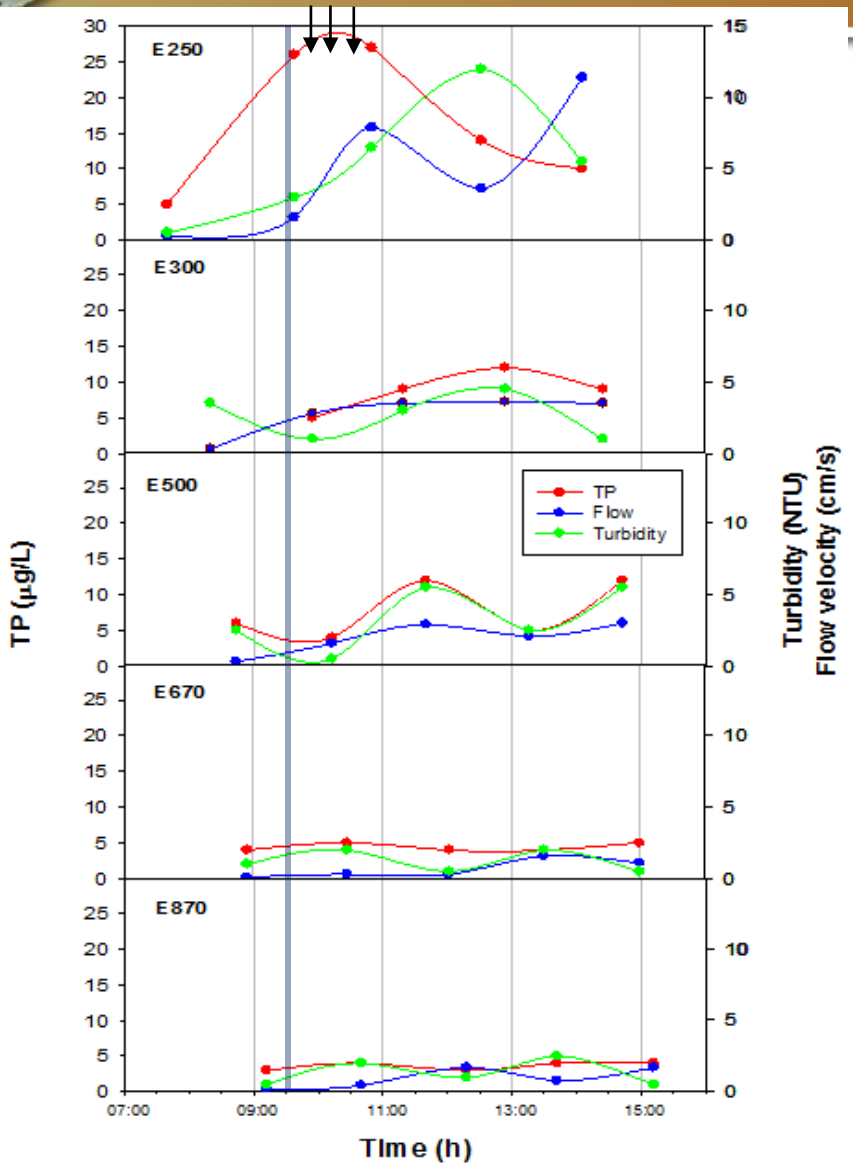
Ridge floc became more “slough-like” after flow

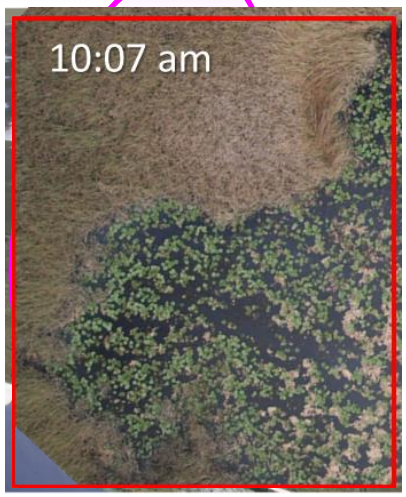


- **Paq is a ratio of fatty acid chain lengths – higher values (>0.4) correspond to slough derived OM (vascular plants only), lower values (<0.3) are ridge-derived**

R. Jaffe, D. He (FIU)

The Initial Pulse - Tracking Phosphorus and Sediment Across the Landscape

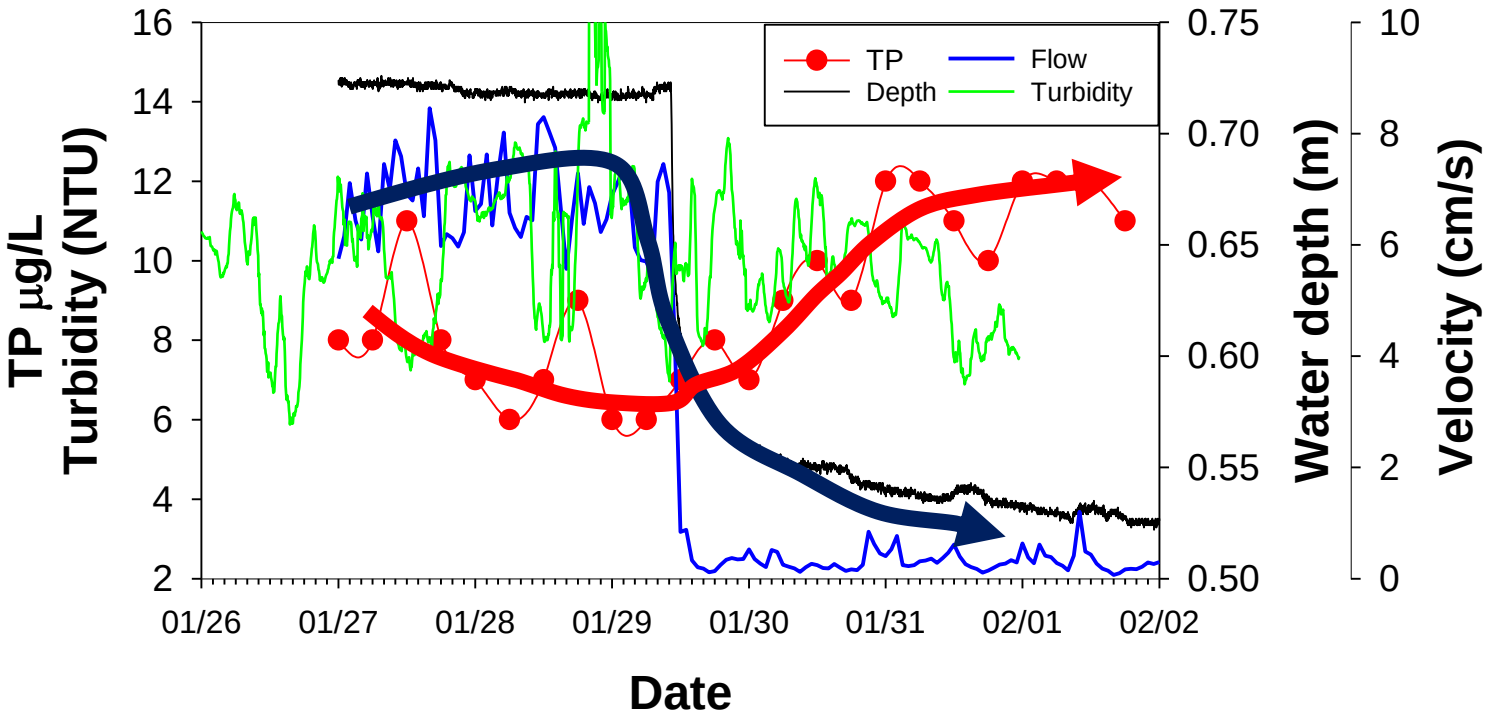




S. Newman, E. Tate-Boldt, C. Hansen, Christa Zweig (SFWMD)

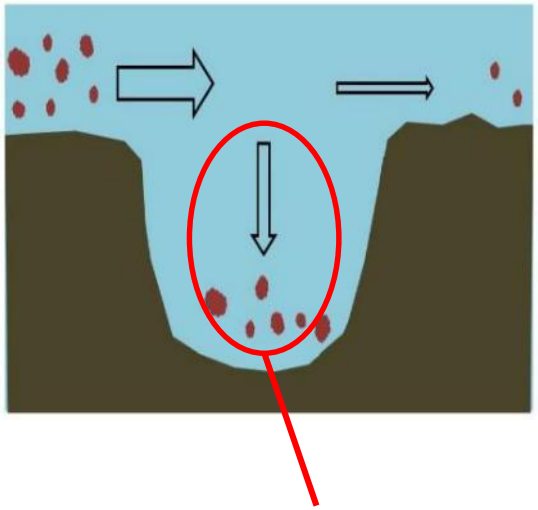
Lessons Learned (Water Quality)

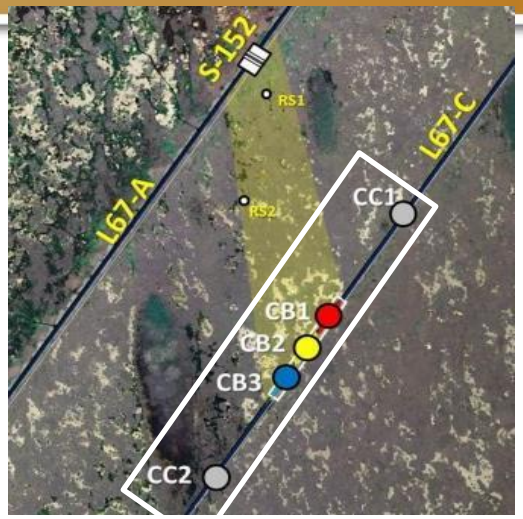
Stopping flow appeared to raise TP concentrations



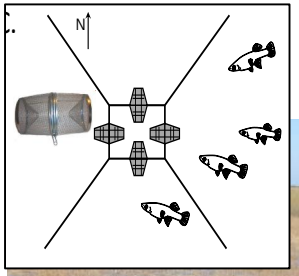
Data from Newman, Cline, Tate-Boldt and Hansen

Is the Canal a Sediment Sink or Source? Role of Backfilling?

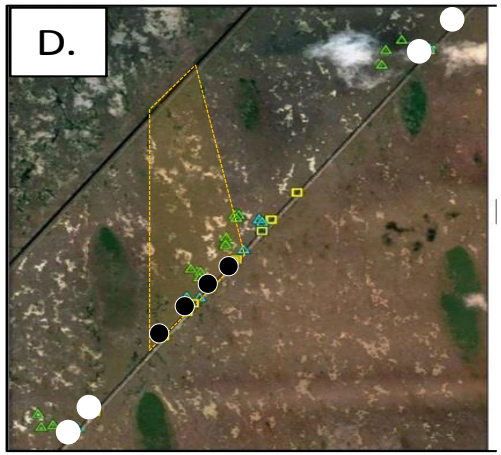


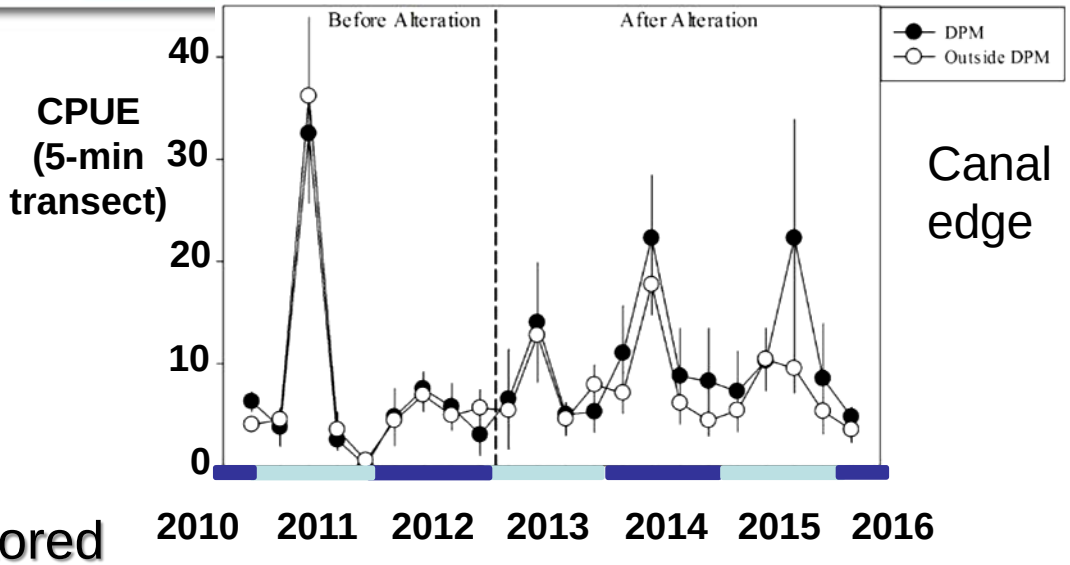


- Canal velocimeters
- Dye tracers
- Vertical sediment traps
- Molecular Biomarkers
- Sediment Chemistry (CNP, LOI)
- Fish sampling



Monitoring Large Fish in L67C Canal



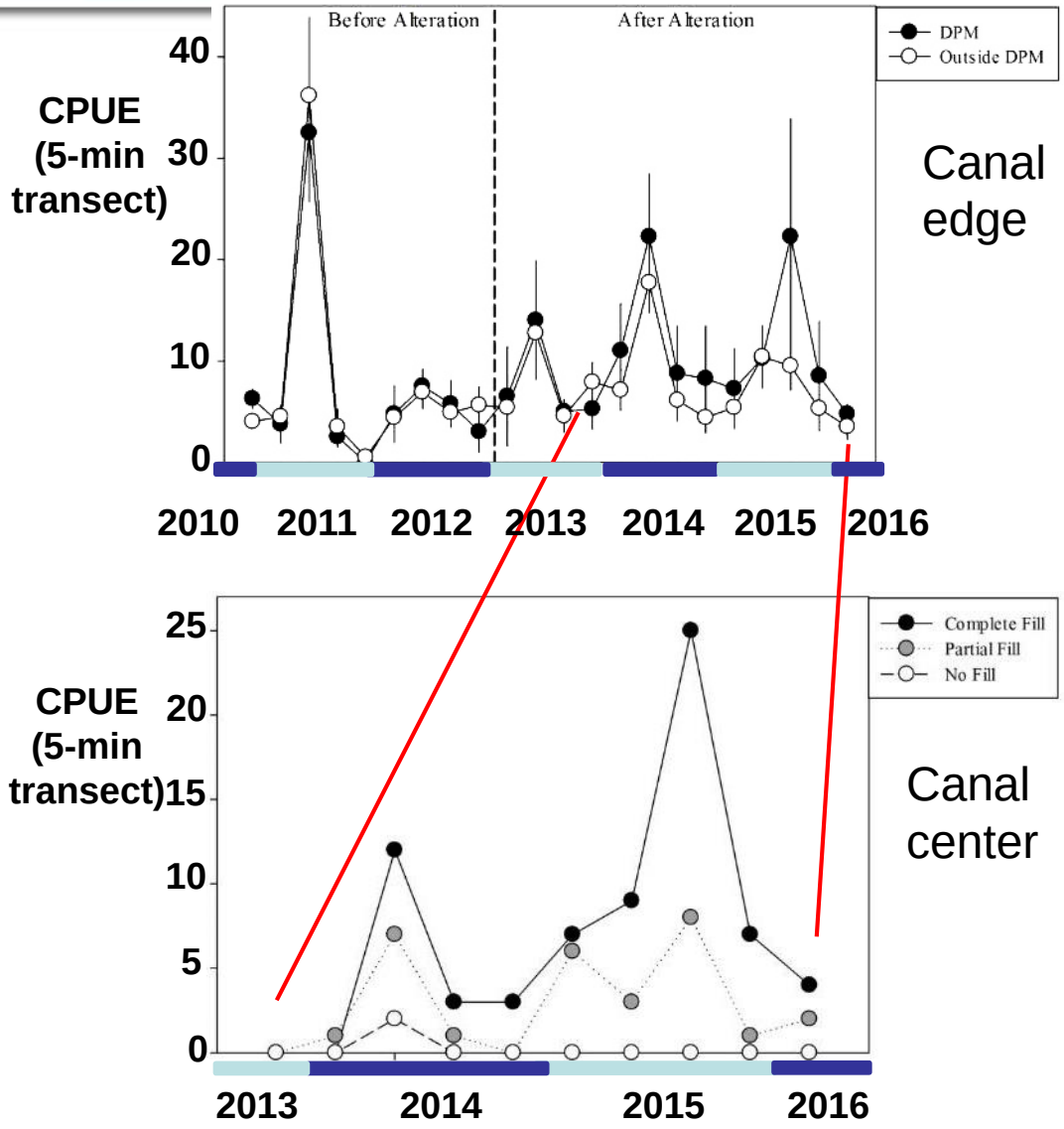


- Starting in 2010, CPUE monitored five times per year
- Electrofishing catch per 5-min.
- Initial sampling focused on canal edges (vegetated littoral zone) - fish seldom observed in canal center

Data from J.Trexler (FIU)

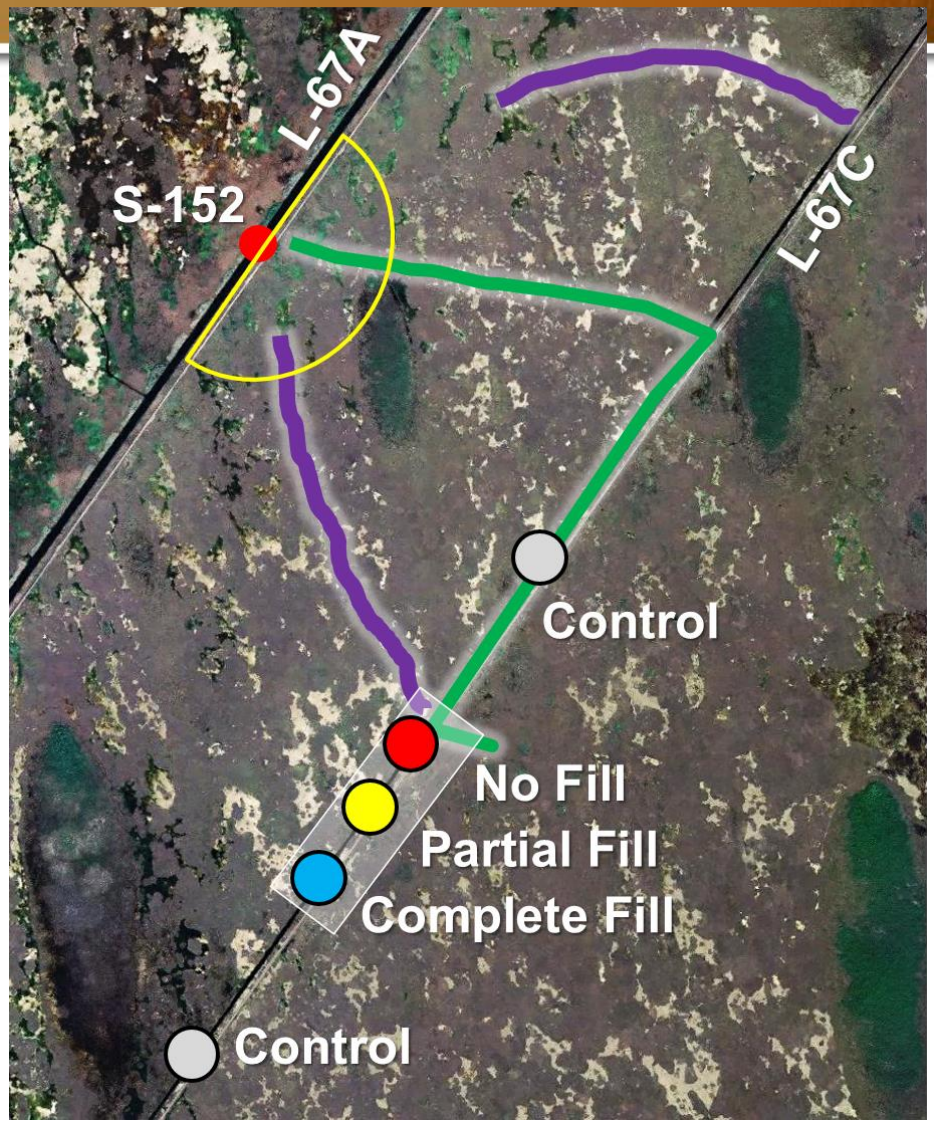
Large Fish Increase in Backfilled Areas

- After construction (started Jan 2013) sampling started in canal center
- Partial & Complete Fill areas attained similar CPUE to canal edges
- Backfill treatments have created more high-quality fish habitat by increasing vegetated areas similar to canal edges



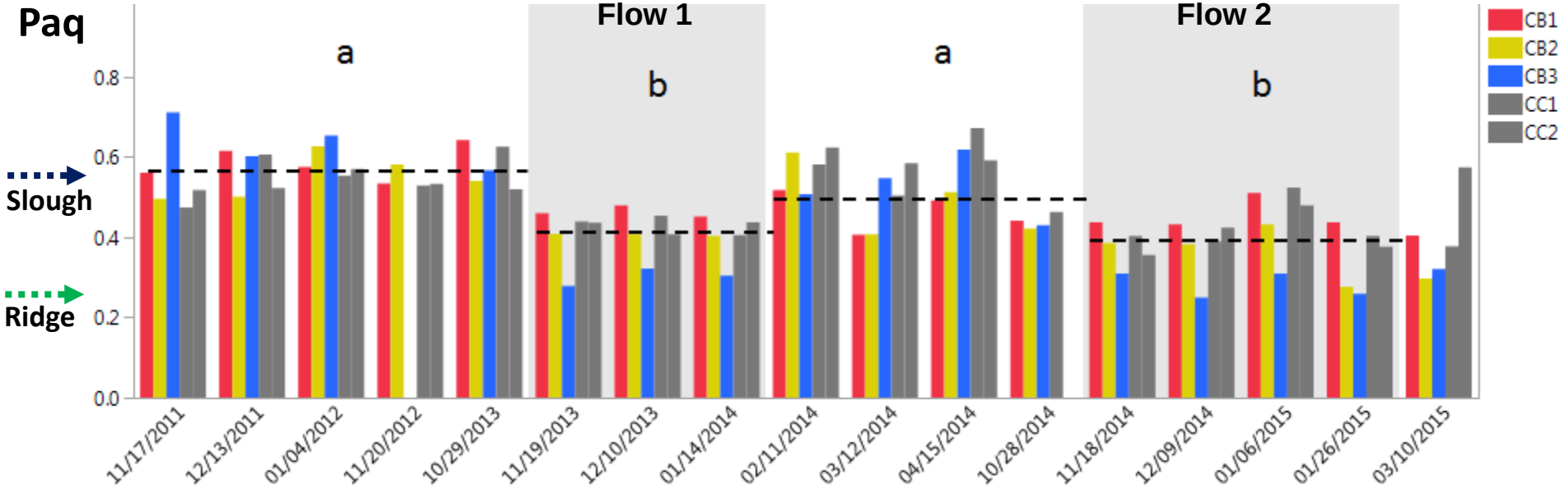
Data from J.Trexler (FIU)

Canal sediment dynamics



Flow altered canal sediment chemistry at all canal sites

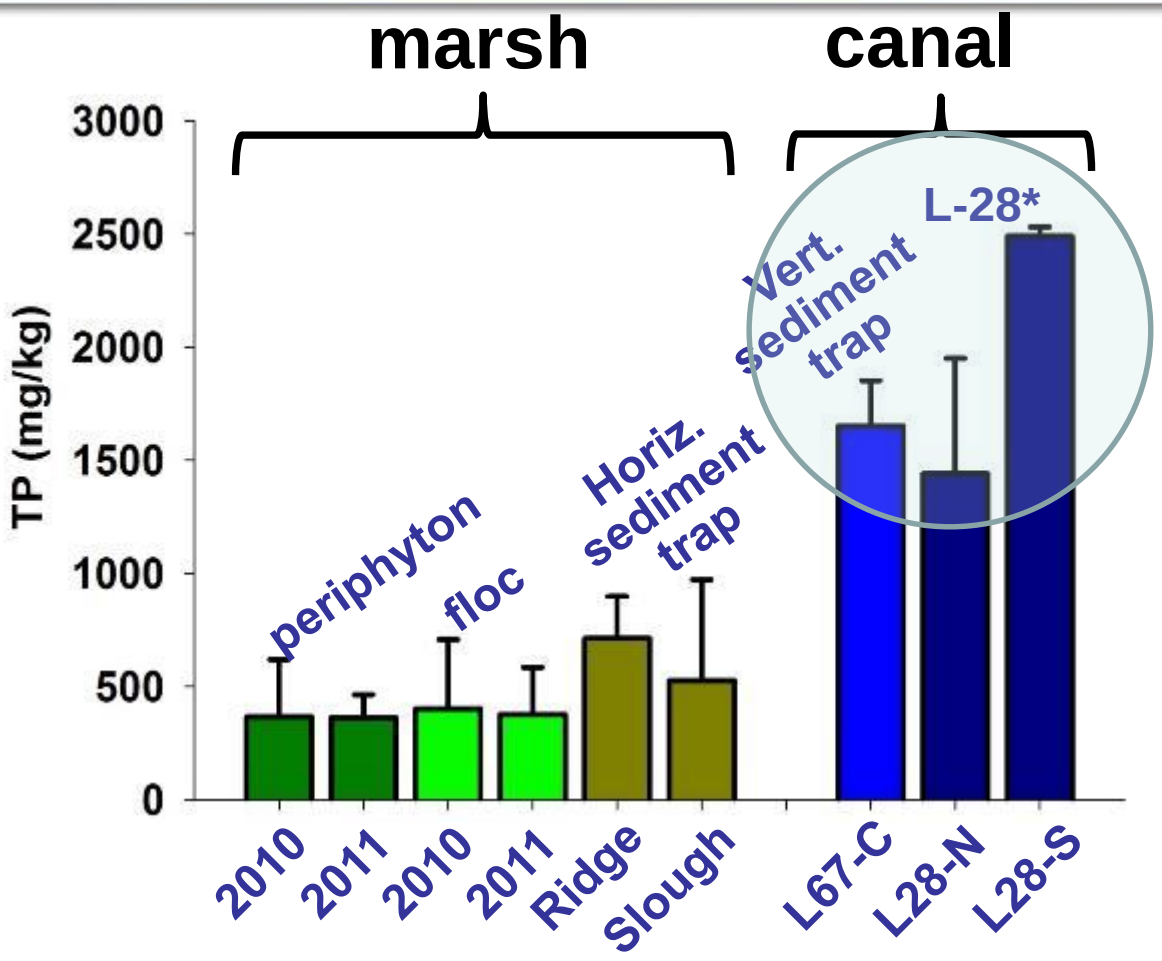
Paq – Slough Macrophyte Indicator



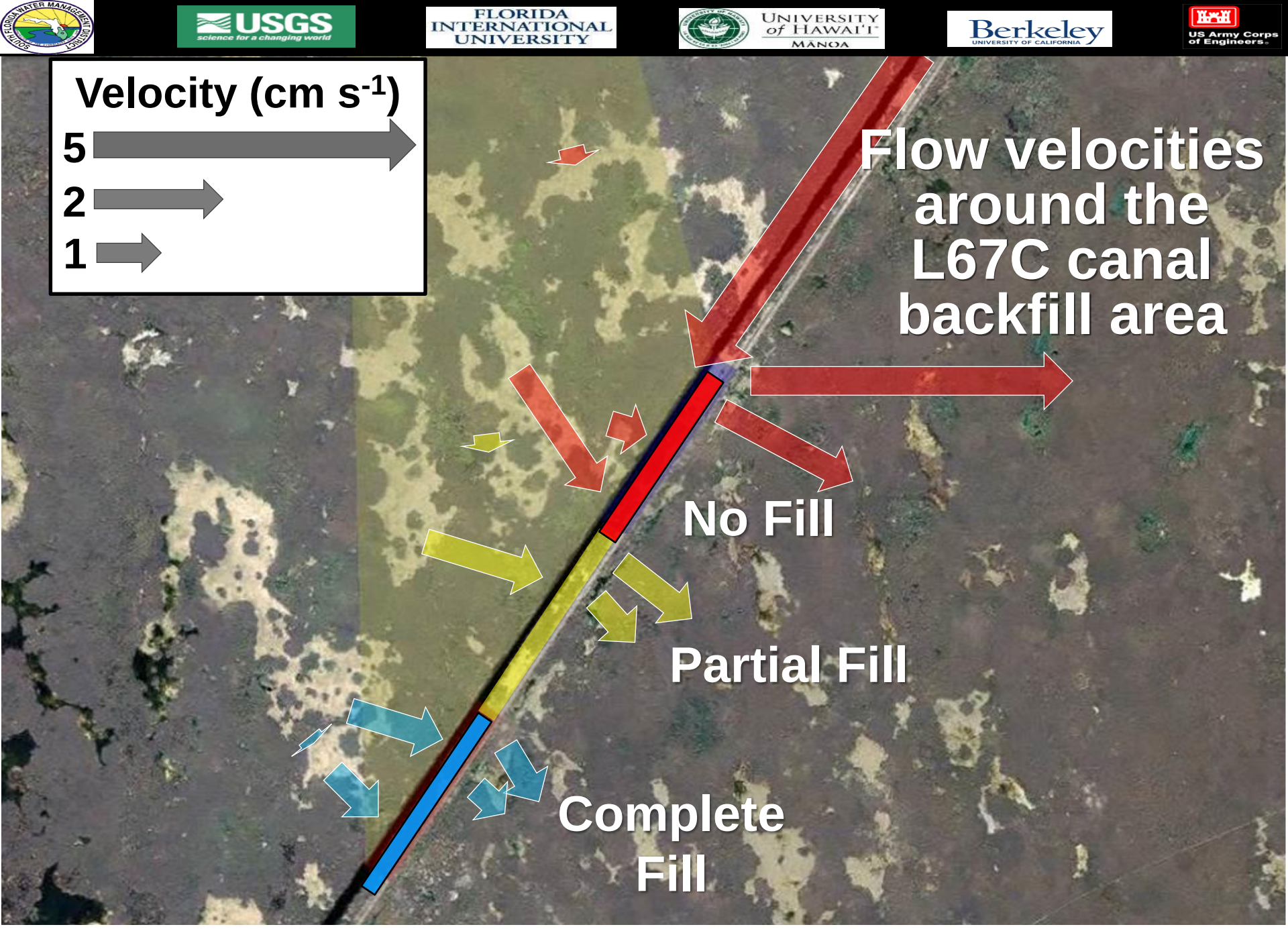
Data from R. Jaffe, P. Regier, and D. He (FIU)

Sediment TP (Marsh vs Canal)

- Phosphorus content highest in canal sediments
- Suggests canal accumulating a local source of sediment
- Canals a potential source of P

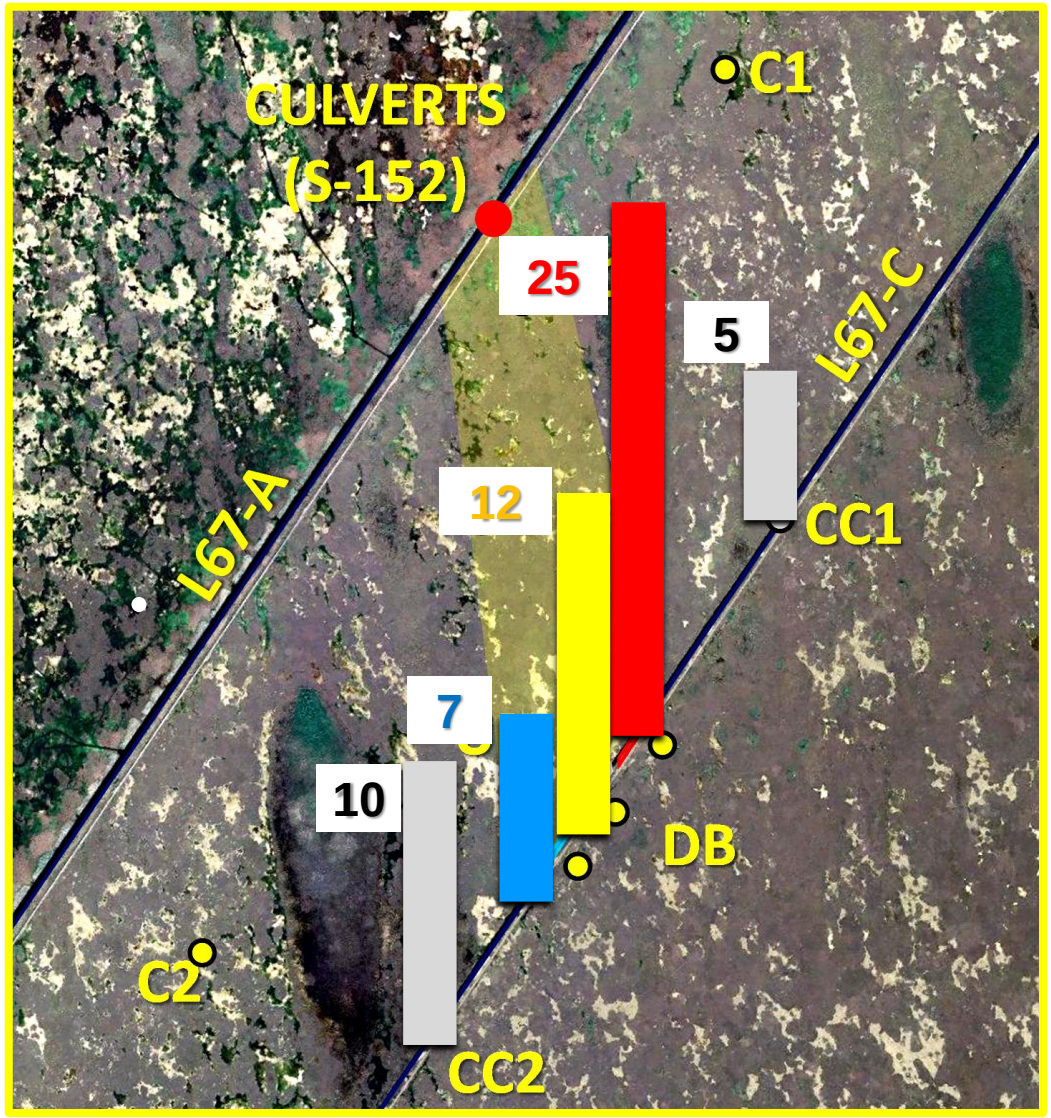


Data from L. Larsen (UCB), Coronado (SFWMD) and Saunders (SFWMD)
*L-28 Merkel & Hickey-Vargas 2000. *Water, Air, and Soil Pollution*



Data from J. Trexler (FIU), J.Harvey (USGS), C.Coronado (SFWMD), E.Cline (SFWMD)

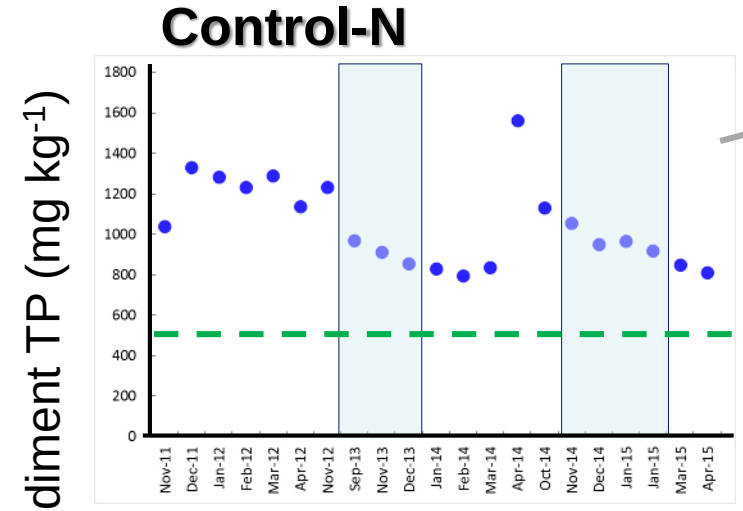
Canal Sediment Accumulation under High Flow (g m^{-2} d^{-1})

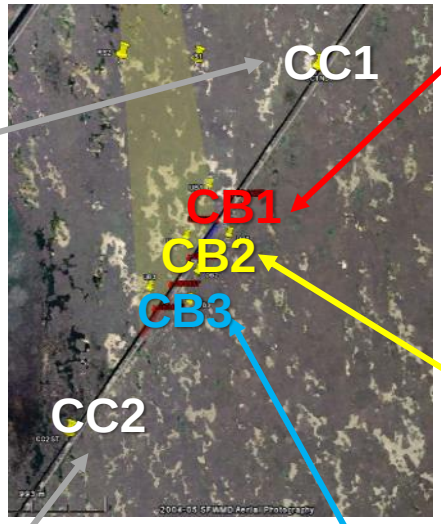


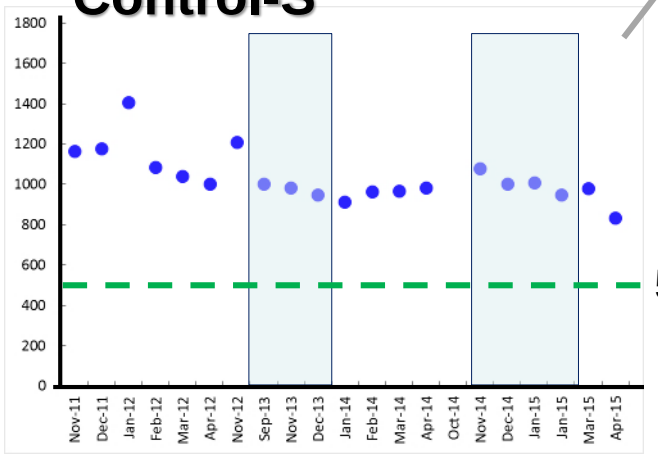
- Re-routing of flow down the canal
- Sediments concentrate and settle at the No-Fill site
- This creates a "hotspot" of sediment accumulation

Data from C. Coronado-Molina (SFWMD)

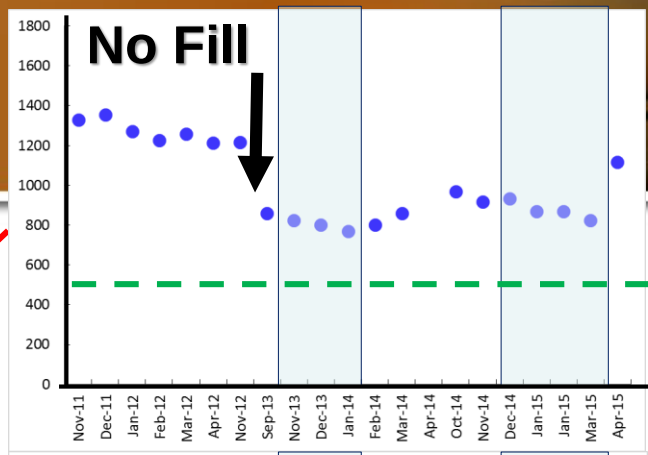
Canal backfilling benefit: decreased sediment TP

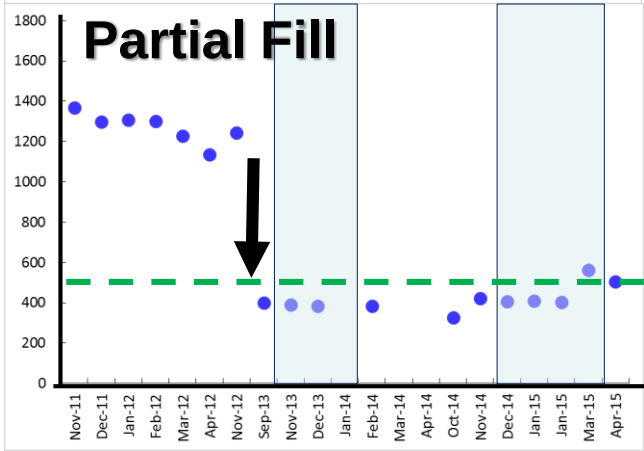


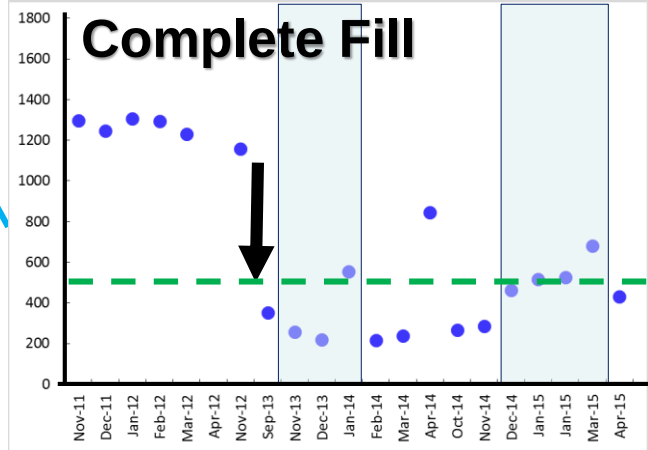




500 mg/kg







Sediment TP (mg kg-1)

Data from C.Coronado (SFWMD)

Lessons Learned (Operational)

1. The interagency operations team proved flexible to adapt to anomalous years like this last flow event. Rapid communication within and among agencies was critical for managing for a strong El Nino, changing operations and adding a new trigger.

2. Having a rich data set (15 years) and especially weekly data in the last 3 years proved essential to operational decisions.

3. This year's data should be helpful for determining how operations (for future DPM studies, and ultimately CEPP) that extend beyond January (the current limit for DPM).

4. The DPM structure will benefit general operations and the management of high water conditions in 3A (e.g., Emergency Orders).

Conclusions - How flow influences ridge-and-slough restoration

- Achieved velocities high enough to erode and redistribute sediments from ridge to slough
- Operations:
  - (1) Initial pulses increase sediment transport 10-fold
  - (2) Sustained flows (10+ weeks) increase slough velocities, reduce slough floc and change floc properties
- Water does not follow the historic flowpath and high velocities are limited to 500-m downstream. Active management may help … *and* …
- The impacts of flow on biogeochemical cycling in algae and floc are being observed further downstream each year

Conclusions - Effects of Flow & Backfilling on Canal Sediment Dynamics

- Backfill treatments improve habitat for large fish, but recovery from disturbance is ongoing
- Flow affected all canal sites due to radial, eastward flow, mobilizing sediments from the canal edge or the canal itself
- Re-routing of flow and sediments down the canal creates a “hotspot” of high-P sediment accumulation and preferential flow in the No-Fill area
- Backfill treatments reduce sediment TP, but they are still recovering from disturbance and re-vegetation